IDENTIFICATION OF ROUND 3 DATA GAPS

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Section 1 Introduction

1.1 Scope and Purpose

The Portland Harbor Remedial Investigation and Feasibility Study (RI/FS) began in 2001 with the collection of data to assess physical conditions at the site. Since that time, additional data collection efforts have included fish, shellfish and invertebrate tissue chemistry, surface and subsurface sediment chemistry, sediment toxicity testing, surface water chemistry and transition water chemistry. Fish and shellfish tissue chemistry and initial sediment chemistry data were collected in 2002 and submitted to EPA in a Round 1 Site Characterization Summary Report dated October 12, 2004. The majority of the Round 2 data were collected in 2004 and submitted to EPA in Round 2A Sediment Site Characterization Summary Report dated July 15, 2005. Round 2 data collection efforts still underway include transition zone sampling, analysis of archived sediment samples, Round 2B sediment cores and the collection of benthic tissue for chemistry and bioaccumulation testing. Round 2 data collection efforts are expected to be completed by the end of 2005.

The current project schedule calls for completing RI/FS characterization efforts by December 2006. In order to ensure that the project remains on schedule, EPA determined that a data gaps scoping exercise was necessary to guide the development of field sampling plans in early 2006 and to assist the Lower Willamette Group (LWG) with project planning. In addition to reviewing current and historic data collected in the Lower Willamette River, EPA has also revisited the Human Health and Ecological Risk Assessments to determine if any modifications to the work plans are necessary and, if so, what additional data may be required to complete these assessments.

1.2 Methodology

The data gaps scoping exercise focused on 4 key areas: Data necessary to confirm the existing conceptual site model, data necessary to support the feasibility study, data necessary to complete the ecological risk assessment (ERA) and data needed to support the human health risk assessment (HHRA). Information reviewed during the data gaps identification process included: Round 1 Data Report (2004), Round 2 Data Report (2005), Programmatic Work Plan (2004), GeoSea Sediment Trends Analysis Report (2001), SPI Survey Repot (2002), Acoustic Doppler Current Profile Survey Reports and Bathymetric Survey Reports (2001 – 2004), Conceptual Site Model Update – Site Summary Reports (2004, 2005), Preliminary Risk Evaluation (2005), Groundwater Pathway Assessment Sampling and Analysis Plan (2005).

Two work groups were formed: An Ecological Risk Assessment (ECO) Team and a Conceptual Site Model (CSM) Team. Team members included representatives of the Oregon Department of Environmental Quality (DEQ) U.S. Fish and Wildlife (USFW), National Oceanic and Atmospheric Agency (NOAA), and Tribal Governments. CSM Team meetings were held on September 6, 7, 22, 28, and November 7. ECO Team meetings were held September 19, October 3, 4, 17, 24 and 25, November 1, 2 and 7. Joint ECO Team and CSM Team meetings were held

on October 19, November 9 and 30. The purpose of the meetings was to review existing information and reach consensus regarding next steps and data needs.

1.2.1 Conceptual Site Model

Data needs relative to the conceptual site were identified through a review of Round 1, Round 2 and historic sediment and surface water data collected up and downstream of the Portland Harbor site. In addition, DEQ staff were consulted regarding knowledge of potential sources of contamination.

1.2.2 Feasibility Study/Areas of Potential Concern

Round 1, Round 2 and historic sediment data were mapped using a range of GIS tools. All data were uploaded into NOAA's Query Manager data base. Data were screened against a number of screening criteria including PECs, TECs and DEQ bioaccumulation screening criteria. In addition, fish tissue data were compared to tissue residue values (TRVs) developed in the PRE. Surface water data were compared to ambient water quality criteria for the protection of aquatic life and human health fish consumption values. Both subsurface and surface sediment data were screened. Data were evaluated in conjunction with knowledge of upland sources of contamination and physical features such as habitat and areas of deposition and erosion and mapped to identify areas of potential concern.

1.2.3 Ecological Risk Assessment

In order to properly identify data needs relative to the ecological risk assessment, a systematic approach was employed starting with the conceptual site model and the Assessment Endpoint table from the programmatic work plan. The CSM was refined to more accurately reflect the relationship between sources, pathways, exposure media and receptors. This information was used to refine the Assessment Endpoint Table. In addition, EPA reviewed the risk assessment approach to identify elements of the risk assessment where changes to the risk assessment approach are necessary. Through this process, EPA has developed the following items: 1) A management goal and objectives to guide the ERA; 2) a revised ecological conceptual site model; 3) revised food web structures; 4) changes to the Assessment Endpoint Table; 5) direction on the ERA approach; and 6) high priority data needs to be filled during Round 3 of the Remedial Investigation.

1.2.4 Human Health Risk Assessment

To be inserted.

Section 2 Conceptual Site Model

The Portland Harbor Superfund Site is located at the lower end of the Willamette River. The Willamette River is approximately 185 miles long and drains a 12,000 square mile watershed that is home to the majority of Oregon's residents and industry. The Lower Willamette River below Willamette Falls is tidally influenced. River flows within this reach vary seasonally from

observed lows in the 5000 cfs range to over 400,000 cfs during the 1996 flood. Due to the size and complexity of the Willamette River system, a robust conceptual site model considers physical factors that control the movement of material within the system as well as sources and pathways of contamination, exposure media and receptors is required.

Although a key component of the upcoming Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report is a refined CSM, a detailed conceptual site model that incorporates physical features, sources, pathways, exposure media and receptors does not currently exist. The current conceptual site model is generally focused on groundwater and includes detailed summaries of upland facilities within the Portland Harbor study area. EPA has reviewed historic, Round 1 and Round 2 RI/FS data to develop a better understanding of how the physical system functions and what information is necessary to confirm or refine this understanding.
It is critical that the refined CSM include the evaluation of existing data collected within or relevant to the Lower Willamette River watershed. This includes the following data sets:

- Semi-Permeable Membrane Device data collected by Oregon State University Researchers;
- Data collected by the USGS through its National Water Quality Assessment Program;
- Data collected as part of the Ross Island remedial investigation performed under DEQ oversight;
- Data collected as part of the Schnitzer and Zidell remedial Investigations performed under DEQ oversight;
- Data collected by the U.S. Army Corps of Engineers to support is Dredged Material Management Program; and
- Mid-Willamette Study performed by DEQ.

In addition, it is clear that additional data collection efforts will be required to further our understanding of the site-wide CSM. These data needs are described more fully in the following sections.

2.1 Contaminant Fate and Transport

Currently, a contaminant fate and transport model for the Lower Willamette River does not exist. EPA believes that a contaminant fate and transport model is critical to the Portland Harbor RI/FS. A contaminant fate and transport model will help identify and understand the impact of sources of contamination both within and outside of the Portland Harbor Study Area and evaluate remedial action alternatives in the Feasibility Study (FS). The following sections describe the data necessary to develop a comprehensive understanding of contaminant fate and transport processes within Portland Harbor and the Lower Willamette River. Data needs are summarized in Table 1.

2.1.1 Contaminant Loading, Suspended Sediment and Bedload

A contaminant fate and transport model sufficient to predict future sediment and surface water concentrations will require estimates of contaminant loading. Contaminant loading should

consider both dissolved and suspended contaminants. Sources of contaminant loading include upstream contaminants transported by the Willamette River, stormwater discharges within Portland Harbor, groundwater flux and overland transport (e.g., sheet flow and river bank erosion. A field sampling plan to gather additional data to support the hydrodynamic sedimentation model (Hydrodynamic Sedimentation Model FSP) was submitted to EPA in November 2005. However, the proposed data collection efforts do not include the collection of contaminant information.

Contaminant loading will require data to estimate loadings from specific upland source areas (See Section 3.2) as well as estimates of upstream loading. Data necessary to estimate upstream loading include sediment traps placed at the upstream end of the Portland Harbor Study area and at selected locations throughout the study area. Suspended sediment data is currently proposed to be collected at river mile 23.7. This location is just downstream from the confluence of Clackamas River with the Willamette River (RM 24.8) and Willamette Falls (RM 26). In addition, suspended sediment data is also proposed to be collected along four transects in the study area (RM 11, 6.3 and 2) and in the Multnomah Channel. This information should be used in conjunction with the surface water data collected at the three transects with the study area to develop estimates of upstream loading, facilitate understanding sediment transport within the Lower Willamette River and improve performance of the hydrodynamic sedimentation model. Data should be collected during high flow events or other events that are expected to transport significant amounts of material to and within the Lower Willamette River.

2.1.2 Sedflume and Settling Velocity

Estimates of settling velocity and erosion parameters are proposed. Sedflume measurements (which include sediment erosion rate, critical shear stress, particle size and bulk density with depth) are proposed at 15 locations within the Portland Harbor study area. Sheer stress, bulk grain size (roughness), and sediment cohesiveness are needed to determine resuspension rates. In addition, in-situ measurements of suspended sediment grain size distribution will be made at 5 locations with the Portland Harbor study area. Grain size distribution measurements will be used to calculate suspended sediment settling velocity. This information will be used to develop estimates of sediment deposition and erosion rates within the Lower Willamette River and improve performance of the hydrodynamic sedimentation model.

2.1.3 Multnomah Channel Hydrodynamic Data

Evaluation of site data suggests that contamination from the Portland Harbor site may be transported into and through Multnomah Channel. This is evidenced by surface water flow measurements that suggest that a significant proportion of the Willamette River flow enters Multnomah Channel and an evaluation of sediment data collected along the west bank of the Willamette River that shows a marked decline in contaminant concentrations between sediment samples collected just upstream and downstream of the entrance to Multnomah Channel.

The current Round 2 Hydrodynamic Sedimentation Model FSP calls for the TSS measurements at the entrance to Multnomah Channel. This data should be supplemented with contaminant concentrations and acoustic Doppler current profile (ADCP) measurements to further understand

the role of Multnomah Channel in transporting contaminants out of Portland Harbor. (See Section 2.3.2 for additional data needs relative to Multnomah Channel.)

2.2 Upstream Data Needs

Additional upstream data is needed to:

- Determine whether contaminant sources upstream of Portland Harbor are being transported into Portland Harbor;
- Estimate contaminant loading from upstream; and
- Determine background concentrations of naturally occurring substances (e.g., metals) and anthropogenic contaminants in the Lower Willamette River watershed.

To facilitate the identification of additional upstream data needs, EPA has divided the river into the following reaches: Upstream of RM 14, RM 11 – 14, RM 2 – 11 (the Portland Harbor Study Area), RM 0 – 2, and the upper reaches of Multnomah Channel. These reaches are depicted on Figure 1 and discussed in the following Sections.

2.2.1 Upstream of RM 14 - Ambient Conditions

Willamette Falls (RM 26) represents the upstream end of the Lower Willamette River. Under most conditions, the falls represent a barrier to the transport of sediment contaminants. This assumption should be verified through the collection of surface water data at RM 23.7 over a range of river conditions. Below Willamette Falls, the river is relatively narrow and in many areas flows through zones of exposed basalt. In addition, sources of contamination within this reach are limited. Known or suspected sources include non-point run-off, permitted NPDES discharges (e.g., POTWs), tributaries (e.g., Clackamas River, Johnson Creek, Kellog Creek) and the Blue Heron and West Linn paper mills located at Oregon City just below Willamette Falls.

Additional data collection efforts (including biota, sediment, and surface water) are required upstream of RM 14 to determine whether contaminants present in this reach of the river are impacting the Portland Harbor Study area. Data upstream of RM 14 can also be used to help establish background concentrations for metals and ambient, system-wide conditions (i.e., baseline). Eric, I think this is where you want to add some text re: sampling above the Falls if you chose.~~Additional sediment, surface water and biota data should be collected upstream of RM 14 to help estimate background concentrations upstream of the Portland Harbor site. Samples collected to estimate background conditions should be collected away from known inputs of chemicals.~~

2.2.2 RM 11 to 14 - Surface and Subsurface Sediment Data for Source Identification

This is the reach of the river that runs through downtown Portland. Although a number of sources have been identified in this reach, because the river is relatively narrow and channelized through the downtown Portland area, it is unclear whether contamination has accumulated in sediments. Key sources in this reach include Zidell and Schnitzer, South Waterfront/Lincoln

Steam Plant, PGE Substation L, City of Portland outfalls, the historic Portland MGP, Tanner Creek and the historic Pearl District, and Cargill. These sources are summarized in Table 2 and presented in Figure 2. Although many of these sources are or have been addressed by DEQ, limited data are available to understand whether significant, uncontrolled, sources of sediment contamination are present within this reach. Additional data collection efforts (including biota, sediment, and surface water) are required at some locations to determine whether contaminants present in this reach of the river are impacting the Portland Harbor Study area and help establish the site boundary.

2.2.3 RM 9.2 – 11 – Subsurface Sediment Data to Complete Characterization

With the exception of the Fireboat Dock (RM 9.7) no subsurface sediment data has been collected within this reach of the Willamette River as part of the Portland Harbor RI/FS. However, during the summer of 2005, the U.S. Army Corps of Engineers (USACE) collected approximately 30 sediment cores within this reach. EPA has identified 3 potential areas of sediment contamination within this reach of the Willamette River. Potential areas of contamination are describe in Section 3 and presented in Figure 3. USACE data should be evaluated and additional subsurface sediment cores should be collected as necessary to evaluate potential areas of sediment contamination within this reach of the Willamette River.

2.3 Downstream Data Needs

Round 2 data collection efforts extended to RM 2. Additional data collection efforts are required to delineate the extent of downstream contamination. As described in Section 2.1.4 above, contaminants from in-water sources along the west bank of the Willamette River may have been transported downstream into Multnomah Channel. In addition, contaminants present in the lower reaches of the Portland Harbor Study Area have extend downstream of RM 2.

2.3.1 RM 0 to 2 – Surface and Subsurface Sediment Data to Delineate Extent of Downstream Contamination

Limited sampling has been performed in this reach of the river. Key sources within this reach of the river include Columbia Slough and Port of Portland Terminal 5. In addition, elevated levels of PCBs have been detected in sediments offshore of the Oregon Steel Mills site (OSM - located at RM 2). These contaminants may have been transported downstream. Additional surface and subsurface sediment data is required to determine whether this reach of the river is being impacted by contamination migrating downstream from the study area or from sources within this reach of the Willamette River.

2.3.2 Multnomah Channel – Delineate Extent of Downstream Contamination

Multnomah Channel begins at RM 3 of the Willamette River and discharges to the Columbia River approximately 15 miles downstream from the confluence of the Willamette and the Columbia Rivers. It is unclear the extent to which contaminants from Portland Harbor ware impacting Multnomah Channel or where these contaminants may settle out. Additional sediment sampling in depositional areas in the upper end of Multnomah Channel is required to determine

whether contaminants released from Portland Harbor may be accumulating in Multnomah Channel.

Section 3 Areas of Potential Concern

To facilitate the identification of data needed to complete the Portland Harbor RI/FS, areas of potential concern were identified. Surface and subsurface sediment data were screened against sediment quality guidelines. A summary of the criteria used to identify area of potential concern is included in Table 3. Generally, non-conservative screening criteria were utilized. For example, probable effect concentrations (PECs) and multiples of DEQ freshwater sediment screening level values (SLVs) were used in order to provide the resolution necessary to distinguish localized areas of sediment contamination from the surrounding sediments. In addition to comparison to sediment quality guidelines, other information was considered such as the relative concentrations of PCB Aroclors and DDT metabolites, comparison of fish tissue data to tissue residue values (TRVs), knowledge of upland sources, plant, amphibian and shorebird habitat areas, human use areas, sediment transport patters, sediment grain size distribution and river bathymetry.

Areas of potential concern are expected to be refined based on additional data collection and cleanup levels generated through the human health and ecological risk assessments. The purpose of the evaluation was to focus on sources of contamination for the purpose of identifying source specific data gaps in addition to data gaps relative to site-wide processes and the human health and ecological risk assessments.

Twenty four areas of potential concern were identified. The names selected for the areas of potential concern are for identification purposes only. For each area, EPA has identified preliminary COIs, mapped the area and developed a size estimate and identified preliminary data gaps. This information is summarized in Table 4 and Figure 3. Data gaps are presented in Table 5 and discussed generally in the following sections.

3.1 Nature and Extent of Contamination

Data gaps related to the nature and extent of contamination include: 1) Contaminants of interest; 2) lateral extent of contamination; 3) vertical extent of contamination; 4) the need for additional surface water data; and 5) the need for transition zone water data.

3.1.1 Contaminants of Interest

Although the Round 2 sampling effort included a large number of analytes, not all chemicals were analyzed for in all locations. For example, volatile organic compounds (VOCs) and polychlorinated dibenzo-p-dioxins and furans (PCDD/PCDF) were analyzed for in a subset of samples. In addition, some contaminants for which sources within Portland may exist were not analyzed for at all. These include manganese and polybrominated diphenyl ethers (PBDEs).

Volatile Organic Compounds: VOCs were analyzed in a subset of sediment samples based on whether upland sources of VOCs were expected to impact the Willamette River. This included

sites such as bulk fuel facilities or where chlorinated solvent plumes exist. VOCs were identified as a data gap at the Willbridge and Willamette Cove facilities due to the likely presence of VOCs in the upland portion of the facility adjacent to the Willamette River and the lack of offshore VOC data. At the Gunderson facility, previous VOC sampling focused on the location of the 1,1,1-TCA groundwater plume. Additional VOC sampling is required in the vicinity of the Shell dock and City of Portland Outfall 18.

Polybrominated Diphenyl Ethers: PBDEs were not analyzed in sediment. Fish tissue samples collected with the support of the Oregon Department of Human Services (DHS) ATSDR, the City of Portland and EPA detected the presence of PBDEs in fish tissue. In addition, a study of PBDEs in the Columbia River included one sample collected off-shore of the Schnitzer Burgard facility. Analysis of this sample revealed the presence of PBDEs. PBDEs were identified as a data gap at the Schnitzer facility due to this detection and the potential for releases associated with scrapping operations. Further evaluation of other potential sources of PBDEs should be performed to identify additional areas where sediment samples should be analyzed for PBDEs. In addition, a subset of sediment samples collected during Round 3 should be analyzed for PBDEs to PBDEs levels across the site.

Polychlorinated Dibenzo-p-dioxins and Furans: PCDD/PCDF were analyzed in a limited number of sediment samples. PCDD/PCDF samples focused on known sources of dioxin (e.g., Rhone Poulenc) and to develop an understanding of dioxin levels across the site. EPA has identified PCDD/PCDF as a potential data gap at PCB source areas. EPA recently requested PCDD/PCDF analysis on a number of archived sediment core samples. This information should be evaluated to determine the extent to which additional PCDD/PCDF data are necessary to complete the RI/FS.

Manganese: Manganese was not included in either the sediment or surface water sampling. However, manganese was analyzed for during the 1997 Portland Harbor Sediment Investigation and the DEQ water quality program has been analyzing Willamette River water collected from the Hawthorne (RM 13) and BNSF (RM 7) railroad bridge since 1990. Manganese was detected above screening criteria in four sediment samples. Manganese was identified as a data gap at sites were manganese was detected above sediment screening criteria or is expected to be present based on upland data (e.g., OSM).

3.1.2 Lateral Extent of Contamination

The lateral extent of contamination was identified as a data gap at sites where additional data was needed upstream, downstream or towards the navigation channel. The degree to which additional data is needed to determine the lateral extent of contamination will depend on cleanup levels determined through the human health and ecological risk assessments, assumptions regarding how far contamination above target cleanup levels may extend and the degree of certainty required in the feasibility study. EPA has provided general guidance on the degree to which additional sampling to delineate the lateral extent of contamination is required at areas of potential concern. Further evaluation of this data gap will have to take place on a location-by-location basis.

3.1.3 Vertical Extent of Contamination

The vertical extent of contamination was identified as a data gap at sites where insufficient subsurface sediment cores were installed. The degree to which additional data is needed to determine the vertical extent of contamination will depend on cleanup levels determined through the human health and ecological risk assessments, assumptions regarding how far contamination above target cleanup levels may extend and the degree of certainty required in the feasibility study. EPA has provided general guidance on the degree to which additional sampling to delineate the vertical extent of contamination is required at areas of potential concern. Round 2B and U.S. Army Corps of Engineers (USACE) Dredged Material Management Plan (DMMP) sediment cores may fill some of these data gaps. Further evaluation of this data gap will have to take place on a location by location basis.

3.1.4 Surface Water

Surface water collected to date has identified exceedances of chronic ambient water quality criteria for the protection of aquatic life at only a few locations. However, ambient water quality criteria for the protection of human health via the fish consumption pathway were exceeded at locations throughout the Portland Harbor. As discussed in Section 2.1.1, contaminant loading data will be needed for Portland Harbor. This data could be used to support the food web model (predict fish tissue concentrations in response to remedial measures to address sediment contamination) or to support TMDL-like efforts aimed at source control efforts. As a result, surface water sampling was identified as a data gap at sites where PBTs are present above screening criteria and/or where additional data to understand contaminant loading to surface water (e.g., via stormwater discharge) from areas of potential concern is required.

3.1.5 Transition Zone Water

Current efforts to collect transition zone water for chemical analysis are focused on areas where contaminated groundwater plumes are suspected of discharging to the Willamette River. EPA expects this effort to continue as necessary. However, in many areas across the site, clean groundwater discharging to the Willamette River has the potential for transporting sediment contaminants to the water column where they may accumulate in tissue at concentrations that pose a threat to human health or the environment. As discussed in Sections 2.1.1. and 3.1.4 above, contaminant loading data will be needed to support the contaminant fate and transport model. It is expected that the current effort to characterize transition zone water in areas of contaminated groundwater discharge will be adequate to estimate contaminant loading associated with contaminated groundwater plumes. However, this will not address the issue of contaminant loading for clean groundwater moving through contaminated sediment. In general, EPA expects that this loading can be estimated through an equilibrium partitioning approach. However, limited transition zone water may be required to validate the partition model(s) selected.

3.2 Contaminant Source Areas and Migration Pathways

Data regarding contaminant source areas and migration pathways are considered fundamental to the conceptual site model. This information will needed on both a site wide scale (e.g., estimates

of contaminant loading associated with specific upland sources) and a localized scale (e.g., estimates of recontamination potential associated with a localized discharge of contamination).

Characterization of contaminant source areas and migrations pathways is generally considered an upland task to be completed under DEQ oversight. However, it is likely that some of this data will be required to complete the Portland Harbor FS. Data needs identified for specific areas of potential concern are focused on upland data necessary to complete the Portland Harbor in-water FS.

Because these data needs are expected to be addressed by upland parties, it is critical that integration of upland and in-water data collection efforts take place as soon as possible and that all upland data needed to support the FS be collected in a time-frame that matches up with the Portland Harbor RI/FS schedule.

3.2.1 Contaminant Source Areas

Contaminant source areas at upland sites must be identified to ensure that the in-water characterization is adequate. For example, were sediment samples been properly located? Have all COIs been identified? In general, contaminant source areas were identified as a data gap at sites where the remedial investigation is incomplete or more information is needed to identify potential sources associated with City of Portland and/or private outfalls.

3.2.2 Stormwater

Stormwater is expected to be a significant source of contamination to Portland Harbor. Contaminant loading data will be required to support the fate and transport model, food web model and evaluate the potential for recontamination. Due to the large number of outfalls present within the Portland Harbor Study Area (more than 300 outfalls have been identified to date), a comprehensive plan for characterizing a stormwater outfalls and developing stormwater loading estimates should be developed and implemented as part of upland source control efforts.

3.2.3 Bank Erosion and Overland Runoff

Bank erosion and overland runoff (sheet flow) is another key mechanism for transporting contaminants to the Willamette River. This data will need to estimate contaminant loading to the system and evaluate recontamination potential. Upland sites where additional data is required to estimate contaminant loading as a result of bank erosion and/or overland runoff have been identified on Table 5.

3.2.4 Groundwater

Groundwater discharges may transport contaminants to the Willamette River. Characterization of groundwater discharges by sampling transition zone water is currently underway (See Section 3.1.5). However, it is critical that upland groundwater be characterized sufficiently to determine whether a complete transport pathway to the Willamette River exists. Upland sites where

additional groundwater characterization is required to complete the upland source control evaluation have been identified on Table 5.

3.3 Evaluation of Remedial Action Technologies

Remedial action technologies that are applicable to contaminated sediments generally include the removal of contaminated sediments through dredging activities, capping of contaminated sediments with clean material, treatment of contaminated sediments and monitored natural recovery. These technologies may be applied alone or in combination. Data needs relative to the evaluation of these technologies must be identified and filled in order to complete the feasibility study.

3.3.1 Monitored Natural Recovery

Additional sampling is required across the site to evaluate monitored natural recovery (MNR) at area of potential concern. This should include Sedflume measurements and the placement of sediment traps at representative areas across the Portland Harbor Study area that can be used to monitor MNR at each area of potential concern. In addition, upstream surface water and sediment monitoring is required as described in Sections 2.1 and 2.2.

3.3.2 Recontamination Potential

Recontamination potential must be evaluated by incorporating Sedflume, sediment trap and contaminant loading (upstream, groundwater, surface water and bank erosion and overland runoff – see Sections 2.1 and 2.2). Data must be sufficient to evaluate recontamination of clean sediment following dredging activities or placement of cap materials. Estimates of recontamination associated with cleanup activities (e.g., dredging and capping operations) will also need to be developed to evaluate pre and post cleanup recontamination potential as part of the FS. The FS should a cleanup sequence that minimizes recontamination potential during the development of remedial action alternatives.

3.3.3 Treatability Studies

Additional sediment sampling may be required to evaluate sediment treatment methods as part of the feasibility study. The current project schedule calls for submittal of a literature survey of treatability studies. This document should be the vehicle for identifying any data collection efforts necessary to support treatability studies at the Portland Harbor site during Round 3 of the RI/FS.

Section 4 Ecological Risk Assessment

The Programmatic Work Plan included an Ecological Risk Assessment Work Plan as Appendix B. However, certain elements of the ecological risk assessment approach were not fully developed in order to allow data collection efforts to begin. Refinements to the ecological risk assessment were expected to be documented in the Comprehensive Ecological Risk Assessment Technical Memorandum (Comprehensive ERA TM). EPA comments on the draft

Comprehensive ERA TM were submitted in October 2004. At that time, it was agreed that finalization of the Comprehensive ERA TM would take place following approval of the Preliminary Risk Evaluation (PRE) Approach Technical Memorandum. The PRE Approach Technical Memorandum was subsequently incorporated into the PRE itself.

EPA has reviewed the Round 2 data and information presented in the PRE to determine if revisions to the ecological risk assessment were required. The Eco Team held focused work sessions in September, October and November to refine the approach for the Ecological Risk Assessment (ERA) and identify data gaps. EPA has determined that the ERA should include a management goal and objectives to guide the ERA. In addition, EPA has determined that the ERA should be modified to include revisions to the ecological conceptual site model, revised food web structures, changes to the Assessment Endpoint Table, and changes in certain elements of the ERA approach. These revisions were utilized to identify Round 3 data collection efforts to complete the characterization phase of the Remedial Investigation and support the ERA.

4.1 Management Goal and Objectives

EPA developed a management goal and management objectives to guide the ERA, as shown below. The goal and objectives explain our reasons for cleaning up the Portland Harbor Superfund Site from an ecological perspective, and provide justification for doing the ERA. The goal and objectives flow from the Problem Formulation statement in the Programmatic Portland Harbor Work Plan, and provide guidance for the Ecological Conceptual Site Model and Assessment Endpoints. They provide direction and priority for current and future characterization efforts necessary to support the ERA.

The management goal and objectives will be used as overall guidance for planning ERA sampling efforts, for justifying studies to fill data gaps, and for providing direction related to the level of acceptable uncertainty in the ERA. They should be incorporated in the rationale or problem formulation sections of all technical memoranda or working documents that relate to Ecological Risk, including the PRE, the Baseline ERA, and the Comprehensive ERA.

<u>Management Goal</u>

Restore, maintain and improve water quality, sediment quality, biological integrity and habitat conditions necessary to support a sustainable and functional ecosystem within the Lower Willamette River, considering current and potential future shoreline and water way use, by reducing or eliminating the potential for exposure to contamination in water, sediments and biota, facilitating restoration activities, and integrating with other regulatory programs.

<u>Management Objectives</u>

1. Reduce contaminant concentrations in riparian soils, sediments, surface water, groundwater, and transition zone water to levels that are protective of the environment and support the restoration and maintenance aquatic and riparian habitats

2. Reduce or eliminate the availability of contaminants to protect semi-aquatic and aquatic plants from deleterious effects.

3. Reduce or eliminate the availability of contaminants to protect benthic and epibenthic species and their food sources from deleterious effects.

4. Reduce or eliminate the availability of contaminants to protect resident and anadromous fish and their food sources from deleterious effects and maintain a safe fish migration corridor.

5. Reduce or eliminate the availability of contaminants to protect aquatic-dependent birds and mammals and their food sources from deleterious effects.

6. Ensure protection of threatened and endangered species, including candidate species, and species of special status and their habitats from the deleterious effects of contaminants.

7. Ensure protection of species and their habitats that are of cultural significance to Tribes from the deleterious effects of contaminants.

4.2 Conceptual Site Model

EPA reviewed the preliminary Ecological Conceptual Site Model (CSM) that was proposed by the LWG (see the 9/9/05 Draft Ecological Preliminary Risk Evaluation, Figure 2-1), and made a number of significant changes. Changes to the CSM were made to reflect the management goal and objectives and to better guide the food web model, dietary model, and overall approach for the ERA. The major changes are summarized below, and the revised Ecological CSM is included as Figure 4.

The "source side" (the left side) of the CSM was refined to better represent the complexity of the physical system: 1) Primary, secondary and tertiary sources and release mechanisms were added; 2) Air, Riparian Soil, Seeps, and Transition Zone Water were added as exposure media; and 3) Willamette River Surface Water, Willamette River Sediment, and Riparian Soil were defined. In addition, 'biota" was changed from an Exposure Media to and Exposure Route, as captured by the "dietary" component to incorporate trophic transfer. These changes were made to incorporate a wider range of potential contaminant-receptor interactions.

On the "receptor side" (the right side) of the CSM, the following changes were made: Three other plant categories: phytoplankton, periphyton, and terrestrial plants were added. Phytoplankton and periphyton were added because they will be assessed as potential contaminant pathways in the food web and dietary models, and terrestrial plants were added for completeness in the ecological system (upland responsible parties are responsible for assessing risk to these species). For invertebrates, zooplankton was added and shellfish were specified under macrofauna because these species will be assessed as potential contaminant pathways in the food web and dietary models. For fish, adult Chinook salmon and adult Pacific Lamprey were added because the adults represent distinct, significant receptor-exposure scenarios that were not addressed in the juvenile life stages. In addition, pathway significance determinations were

redefined and some changes were made regarding the completeness and significance of these pathways.

Inset summary of changes to Pathway Significance designation.

4.3 Measures of Exposure and Effect

EPA has reviewed the Assessment Endpoint Table included in the Programmatic Work Plan Proposed changes to the Assessment Endpoint Table are include in Table 6. The left three columns of Table 6 provide information from the LWG's proposed Assessment Endpoint Table. The right three columns of Table 6 provide changes and comments from EPA and partners, including justification and data needs. The data need numbers listed in the table correlate to the data needs identified in the Data Needs Table.

4.4 Food Web Model Approach

EPA and partners reviewed the preliminary Fish and Wildlife Food Web Models proposed by the LWG in the April 2004 Programmatic Work Plan (Figures 5-4 and 5-5). EPA proposed changes to the preliminary Fish and Wildlife Food Web Models are summarized below. Note: These models are sufficient as general guidance to represent the food web, but they may not provide adequate detail for the Food Web Model and the Dietary Approach.

The following changes to the Fish Food Web Model (Figure 5-4) are required:

- Box shading: all boxes should be shaded, except the "Surface water, sediment, and porewater (transition zone)" box, the "Primary producers" box, and the "Zooplankton and drift organisms" box. Add a footnote to the "Primary producers" box and the "Zooplankton and drift organisms" box that states: "These receptors will be assessed as potential pathways for contaminant migration through the food web. They will not be assessed as endpoints themselves."
- Add an arrow from "Detritivorous fish" to "Omnivorous/herbivorous fish," to represent sturgeon consuming detritivorous fish.
- Add an arrow from Epibenthic invertebrates to Piscivorous fish to represent bass and pikeminnow eating crayfish.
- Add arrows from "Zooplankton and drift organisms" to both "Infaunal invertebrates" and "Epibenthic Invertebrates."
- Add a footnote to Epibenthic invertebrates that states "For crayfish, consider scavenging at higher trophic levels."
- Add a footnote to sculpin in the Invertivorous fish category that states "For sculpin, consider feeding within the same trophic level."

In addition, the following changes to the Wildlife Food Web Model (Figure 5-5) are also required:

- Add arrows from "Zooplankton and drift organisms" to both "Infaunal invertebrates" and "Epibenthic Invertebrates."

- Add an arrow from “Reptiles” to “Amphibians.”

In addition, a “real-life” visual, colorful image of the food web is needed as a communication tool for public audiences and interested stakeholders. The visual image should include a cross section of the river in Portland Harbor showing habitat areas, and representatives of the benthic and epibenthic communities, native resident and anadromous fish species, and key wildlife receptors.

In addition to changes in the food web model structure, EPA has determined that additional data is needed to support the food web model. Key data gaps include: *Add data gaps based on FWM meeting.*

4.5 Risk Assessment Approach

EPA and partners discussed key aspects of the approach for conducting the ERA, including methods the LWG has proposed and additional methods that are needed. Attachment C provides initial direction on the ERA approach. Additional direction for other areas of the approach, including the assessment of to lamprey, will be provided by EPA and partners over the coming months.

4.5.1 Approach for assessing risk from PAHs to resident and anadromous fish

Assessing risk to resident and anadromous fish from PAH exposure in the Portland Harbor is a critical aspect of the ERA due to the prevalence of PAH contamination in Portland Harbor and because literature data indicate that some fish may be more representative of PAH exposure or more sensitive to the effects induced by PAHs than other fish. For example, strong associations between PAH concentrations and measures of exposure and effect have been demonstrated in the literature. Effects associated with PAH exposure include: 1) depressed immune system function (immunosuppression), increased susceptibility to disease, and impaired growth in experimentally-exposed juvenile salmonids; 2) increased prevalence of liver lesions, skin lesions, and biomarker responses in brown bullhead exposed to sediment PAHs in the field; and 3) increased liver lesions, hepatic cytochrome P4501A (CYP1A) induction, and xenobiotic-DNA adduct formation in experimentally-exposed flounder and sole. These studies indicate that juvenile salmonids are sensitive to PAH toxicity and resident fish exposed to high concentrations of PAHs from river sediment can be good indicators of exposure and effects.

The current approach for assessing risk to fish from PAHs is based on: 1) the dietary approach, using a concentration-based exposure rather than dose-based exposures; and 2) water exposure related only to a single PAH compound compared to Ambient Water Quality Criteria (AWQC). EPA has determined that these methods alone will not be sufficient for assessing PAH risk to fish due to a paucity of dietary TRVs and the ability to accurately model dietary exposure based solely on concentrations in food items limits the effectiveness of the dietary approach. In addition, PAHs may have a *combined* effect on fish and it is important to consider potential combined effects in assessing risk.

EPA has determined that a multiple line of evidence approach is required to properly assess risks associated with PAH exposure. The lines of evidence listed below are essential to reduce uncertainty in the proposed approach for assessing risks associated with PAH exposure.

- Modify the dietary approach: Express the concentration received by the fish as a dose (e.g., mg chemical/kg fish) rather than solely the concentration in the prey item. There are more reliable TRVs available for comparison when diet is expressed as a dose. Include water concentrations in the model (incorporating water temperature and gill ventilation rates) because a small concentration of PAHs in a fish can result in a huge dose (i.e., uptake efficiency of PAHs can be as high as 50%).
- Chemically analyze stomach contents: Chemical analysis for PAHs in stomach contents of resident fish will better represent what the fish are actually exposed to as compared to only evaluating PAHs in potential prey items. Uptake of PAHs by invertebrates is highly variable and the type of prey evaluated by LWG may not represent what the fish actually eat or the PAHs in the actual prey items. Stomach content analysis will provide a much more realistic exposure scenario and will be used to help verify dietary approach parameters, provide information on the type of prey items the fish consumed that are contaminated (important for the food web model), and better represent the specific types of PAHs the fish was exposed to (needed for attributing PAH groupings to sources). Analysis of stomach contents is critical if resident fish are to be used as a representative for sturgeon, and should be conducted on any sturgeon collected from the site.
- Sediment thresholds derived by the NOAA Science Center: These thresholds will be helpful for assessing risks to individual fish by linking the incidence of fish lesions with sediment concentrations (i.e., use existing sediment data and sediment quality guidelines to help predict if and where lesions would be expected). Round 1 fish tissue data and fish lesion data collected as part of the McCormick and Baxter Remedial Investigation should be reviewed to determine the prevalence of fish lesions in Portland Harbor.
- Use invertebrate surrogate toxicity: Using invertebrate toxicity associated with PAH sediment contamination could be used to predict whether effects on fish are expected.
- Develop species sensitivity distributions: Although the data is limited, a species sensitivity distribution could be developed to create sediment guidelines.
- Water concentration approach: Compare water column PAH data to pseudo screening numbers in the EPA sediment equilibrium partitioning guidance document.

4.5.2 Approach for assessing risk from PAHs to birds and mammals

Because many PAHs are metabolized in fish and do not readily transfer up the food chain, exposure to higher trophic level receptors such as birds and mammals from ingesting contaminated prey is difficult to measure and considered complete and insignificant in most cases. However, ingestion of PAHs for birds lower in the food chain such as sandpipers and mergansers should be modeled through a dietary approach if appropriate TRVs are available.

4.5.3 Approach for assessing risk from metals to fish

Currently, to assess risk to fish from metals, the LWG proposes to use (1) the dietary approach and (2) comparisons of dissolved metal concentrations to Ambient Water Quality Criteria

(AWQC), with the assumption that AWQC will be protective of all fish. These methods are not adequate for assessing risk to fish from metals exposure because our understanding of gill uptake efficiencies and ventilation rates resulting in toxicity are somewhat limited. Options to improve the assessment include using biomarkers such as metallothionene and using the Biotic Ligand model that EPA is developing.

EPA expects that PCBs (and other organochlorine compounds) and PAHs will be a primary focus of the risk assessment due to their prevalence at Portland Harbor. Rather than pursuing the additional lines of evidence noted above for assessing risk from metals, ERA efforts should focus on PCBs and PAHs except in localized areas of metal contamination. In metal-contaminated areas, the ERA should rely on toxicity to the benthic community to assess metals risk as opposed to tissue residue levels (tissue residue levels for metals are less reliable because fish regulate metals), and look at fish-specific water TRVs.

The TRV/direct toxicity assessment is sufficient for assessing risk to clams and invertebrates. For birds, the proposed dietary approach for assessing metals risk is sufficient, with the possible exception of getting verifiable tissue data. Options for getting bird tissue data include evaluating prey items fed to nestlings using a dietary ligature approach. This approach would allow for identification and chemical analysis of prey items and can be used to assess metals risk as well as other contaminants, and this approach may be most needed at specific site locations. Swallows are commonly used to assess risk at PCB sites based on dietary ligature information as well as assessing reproductive endpoints.

The approach for assessing risk to fish and invertebrates from mercury includes the benthic interpretive model and the tissue residue approach. These approaches are adequate. The approach for assessing risk to amphibians, birds and mammals from mercury includes the dietary approach and evaluating the accumulation of mercury up through the food chain to birds. This approach is adequate, but we may need to review the TRVs to ensure they're appropriate and protective enough.

4.5.4 Approach for assessing risk from organometals to fish

The current approach for assessing risk to fish from organometals (e.g., tributyltin [TBT] and other butyltin compounds) relies primarily on assessing risk to clams and mussels. TBT is highly toxic to gastropods and is bioaccumulative in invertebrates. However, it does not appear likely that native gastropods are present in the Portland Harbor area. The current approach should include an assessment of risks to fish from TBT exposure based on Meador, JP (2000)[1], and a localized TBT risk assessment for TBT contaminated sites.[2]

[1] Meador, J.P. 2000. An analysis in support of a sediment quality threshold for tributyltin to species for juvenile salmonids listed by the Endangered Species Act. Final Report. Northwest Fisheries Science Center, NOAA, Seattle, WA. 19 p

[2] Note: The Meador paper may not be protective of gastropods or mollusks. For gastropods, the assessment should focus on the gastropod bioaccumulation and how this affects birds. For mollusks, TRV approach for assessing risk from TBT should be compared to Meador's recommendation of a sediment cleanup level that is ten or more times lower than 6,000 ng/g organic carbon.

4.5.5 Approach for assessing risk to sturgeon, Chinook and lamprey

The LWG's proposed Assessment Endpoint Table and the Ecological CSM identify sturgeon, juvenile lamprey and juvenile Chinook as receptors of concern. EPA and partners added *adult* lamprey and *adult* Chinook as receptors of concern because complete pathways exist to these receptors that are not represented by other species or by the juveniles, and because the adults are culturally significant to the Tribes. EPA is considering whether sturgeon and lamprey will be assessed and protected at an *individual* level, rather than at a population level, to reflect the special status of these species to the Tribes and because some data indicate that these species have declined in much of their range.

- Assessing sturgeon

  The current approach for assessing risk to sturgeon is through an assessment of resident fish, such as largescale sucker and pikeminnow, as sturgeon representatives. Because of their potentially large home range, sturgeon are likely exposed to contaminants from areas outside of the ISA over the course of their lifetime (up to 100 years). For this reason, resident fish represent adult sturgeon in the Ecological CSM and Assessment Endpoint Table because these species would incorporate a higher site use in the model for the sturgeon (i.e., be more conservative) and could better represent dermal uptake of PAHs compared to other resident fish (based on the sucker's bottom feeding natural history).

  The current proposed approach for assessing risk to sturgeon is not adequate alone, and needs to be supplemented as follows: Largescale sucker and pikeminnow should be used in preliminary food web analyses as the representative of all species, including sturgeon, in the "omnivore/herbivore" guild to estimate tissue concentrations in pre-breeding and adult sturgeon. However, because of ecological and natural history differences between largescale sucker/pikeminnow and sturgeon, protection of these surrogate species may not provide adequate protection for sturgeon. Because the available sturgeon data only includes fillet tissue from pre-breeding sturgeon and does not include any adult sturgeon tissue data, the collection of additional sturgeon tissue within the ISA is necessary. Sturgeon sampling should focus on the size range believed to represent resident pre-breeding individuals. Concentrations of analytes obtained from empirical tissue analyses from these individuals should be compared to: 1) levels in composite tissue samples of other fish receptors; 2) estimated tissue levels for largescale sucker and pikeminnow based on food web model results; and 3) estimated tissue levels for largescale sucker and pikeminnow based on direct dietary models (based on the concentration and/or dose per day of contaminants in prey) to assess whether protection of largescale sucker and pikeminnow will be protective of sturgeon. In addition, concentrations of contaminants in adult sturgeon should be estimated using a regression model (size as a proxy for age on X-axis, and tissue concentration on the Y-axis) based on empirical data from pre-breeding sturgeon. As with pre-breeding sturgeon data, these estimates of adult tissue contaminant concentrations must also be compared to (1) estimated tissue levels for largescale sucker and pikeminnow based on food web model results, and (2) estimated tissue levels for largescale sucker and pikeminnow based on direct dietary models.

It is likely that the estimates of tissue concentrations in adult sturgeon from the above analyses will be highly protective of adult sturgeon because of the 100% residency assumption and the modeling of juvenile tissue concentrations over the lifetime of adults (50 to 100 years). This is likely to result in risk levels that are beyond maximum clean-up levels. If the LWG believes that such results are overly conservative and wants to reduce risk estimates by reducing the adult residency assumption to less than 100%, additional empirical data would be needed to support such a change. If appropriate empirical data already exist (e.g. Columbia River radiotelemetry studies), EPA and partners can evaluate these data and determine whether they are sufficient or whether additional data collection from the ISA is needed. Alternatively, the LWG may choose to begin gathering ISA specific data on adult sturgeon residency before the above analyses are complete, because one to three years of data collection will be required to gain useful information.

- Assessing Chinook

  Although adult Chinook take up contaminants during migration through the ISA, protecting juvenile Chinook is expected to be sufficiently conservative to ensure protection of all life states. However, protection of juvenile Chinook does not take into account the effect of contaminants on returning, pre-spawning adults that may suffer impaired olfactory function from copper and other metals. Impaired olfactory function affects the ability of adults to find spawning sites and effectively reproduce. Surface water metal concentrations should be compared to known effect levels for adult olfactory function to assess risk to adult Chinook.

  The dietary pathway for bioaccumulative contaminants for adults is considered to be insignificant. This pathway is significant primarily to yearlings and sub-yearlings that are eating invertebrates during their time in the ISA.

  The process for assessing risk to juvenile Chinook should include collecting data on juvenile Chinook tissue and diet, and using peamouth as a surrogate. Peamouth should provide conservative risk estimates because it is a resident species, but the juvenile Chinook and peamouth diets differ enough to warrant using a dietary model to estimate risk to juvenile Chinook based on their actual diet (which primarily includes daphnia based on existing studies).

- Assessing lamprey

  EPA and partners are still evaluating potential approaches for assessing lamprey in the ERA. Direction from EPA and partners to the LWG on lamprey assessment will be provided soon.

4.5.6 Approach for developing BSAFs for clams, crayfish and sculpin

BSAFs for clams, crayfish and sculpin are needed to describe the relationship between contaminant concentrations in tissue and sediment in the ISA. In addition, if a sufficiently robust relationship can be developed, BSAFs will assist with estimating tissue concentrations in areas in which receptor tissue samples were not collected, developing clean up levels for bioaccumulative contaminants, and informing the ERA Dietary Approach and Food Web Model. BSAFs can be

used on a Harbor-wide basis and developed for specific sites to represent localized sediment-tissue contaminant concentration relationships. Data analysis will tell us whether we have a strong sediment-tissue relationship Harbor-wide, and data outliers could indicate areas where additional site-specific BSAFs should be developed for local areas (additional sampling may be needed in these areas). We also will consider possibly developing BSAFs for lamprey ammocoetes and sucker.

The current approach for developing BSAFs is to use field-collected clams and do lab tests with clams and *Lumbriculus*. EPA and partners will need to evaluate the data generated from this effort to determine whether the various sediment-tissue relationships are strong enough, and to decide whether additional sampling is needed. In addition, we need to evaluate the existing crayfish-sediment data and sculpin-sediment data to determine the strength/quality of the tissue-sediment relationships. Additional data collection may be needed to improve the sculpin-sediment contaminant concentration relationship and provide additional information to explain some of the outliers. In the future, the LWG needs to analyze for Acid Volatile Sulfides and Simultaneously Extracted Metals.

4.5.7 Approach for assessing risk to the benthic community:

The proposed approach for assessing risk to the benthic community includes (1) laboratory toxicity tests as the primary line of evidence (an empirical and predictive approach), and (2) comparing tissue concentrations from field collected clams and crayfish to tissue based TRVs. This approach is not adequate because (1) lab toxicity tests are spatially limited, and (2) field collected tissue is spatially limited and informative for only two species that may not adequately represent other benthic organisms. In addition, this approach is missing analyses of the benthic infaunal community.

In addition to the proposed approach, the LWG needs to use Equilibrium Partitioning (EQP), which takes into account bioavailability, is useful or assessing risk from metals, and provides information with greater certainty. This approach typically requires K_{OC} data, water quality criteria, and pore water data, but since pore water data is not available for Portland Harbor, pore water contaminant concentrations could be estimated. Site specific pore water data may need to be collected in some areas, however, to refine our estimates. Also, benthic tissue concentrations should be compared to TRVs.

4.5.8 Approach for assessing risk in the riparian area

A portion of the lower riparian area within the ISA provides important habitat for receptors of concern, and as such, it must be considered in the ERA. EPA and partners defined the lower riparian area as river bank that extends up to the Ordinary High Water Mark (OHWM), and agreed that the Portland Harbor Remedial Investigation must include assessment of this area. Some upland Responsible Parties are responsible for assessing the upland area down to the Mean High Water Mark, but these assessments are done relative to discrete sources, rather than being designed to assess continuous risk to aquatic receptors in the ISA. Assessment of the lower riparian area by the LWG is important to provide consistency in the assessment and in protection of the species that use the area throughout the ISA.

4.5.9 Scale of the ERA

The LWG has proposed developing Harbor-wide cleanup levels during the RI/FS, and developing site- ~~more~~ specific cleanup numbers in the RDRA phase. EPA and partners agree that looking at site wide cleanup levels is acceptable for now, but additional cleanup levels may be needed for localized contaminant areas before completion of the RI/FS, and additional data collection may be required. EPA and partners are concerned that risk information was not collected to support the Early Actions (T4 and Gasco), and that site specific risk assessments will be conducted during the RI/FS when needed. From this point forward, EPA and partners will direct the LWG to conduct more sampling and analysis than the minimum level needed to assess Harbor-wide risk or develop Harbor-wide cleanup levels because we are interested in localized risk in some areas.

4.5.10 Weighting different lines of evidence for the ERA

In the near future, EPA and partners will provide develop an approach for weighting different lines of evidence for different contaminant families (metals, PAHs, PCBs, other organics, etc.). A weighting approach will be needed to focus the risk assessment (beyond the screening level) on those exposure pathways that are most important for driving risk to different receptors. EPA and partners will provide direction on the weighting approach to the LWG when it is available.

4.6 Data Gaps

EPA and partners discussed data collected thus far for the ERA, and identified high priority data needs to be filled in Round 3 of the Remedial Investigation. Attachment D provides the Data Needs Table, which includes information on how the additional data will be used and how the data need should be filled.

Over the next few months, EPA and partners will develop direction on the approach for assessing Pacific Lamprey, and additional data needs for Lamprey may accompany that direction. In addition, EPA and partners are evaluating the LWG's proposed Food Web Model, and additional data needs for the model may accompany our comments on the proposal.

Section 5 Human Health Risk Assessment

For the ERA, EPA and its partners developed a management goal and management objectives to guide the ERA. To be consistent with the ERA, management goal and management objectives have also been developed for human health. The management objectives are a modification of the Remedial Action Objectives listed for human health in the PH RI/FS Programmatic Work plan (Section 6.1). The goal and objectives explain our reasons for cleaning up the Portland Harbor Superfund Site from a human health perspective, and they provide justification for doing the HHRA. They provide direction and priority for current and future sampling and analysis work related to human health

5.1 Management Goal and Objectives

The following management goal and objectives should be used to guide the Human Health Risk Assessment (HHRA).

5.1.1 Management Goal:

Restore, maintain, and improve water and sediment quality and reduce or eliminate the potential for human exposure to contaminants in water, sediments, and biota in the Lower Willamette River to ensure protection of public health considering current and future river and shoreline use.

5.1.2 Management Objectives:

Management objectives include:

1. Reduce contaminant concentrations in surface water to levels that are protective of human health, including tribal and subsistence populations, from ingestion of and dermal absorption of contaminants in surface water, and from ingestion of fish and shellfish that bioconcentrate or bioaccumulate contaminants in surface water.
2. Reduce contaminant concentrations in transition zone water to levels that are protective of human health, including tribal and subsistence populations, from ingestion of shellfish and to levels that would attain the surface water management objective.
3. Reduce contaminant concentrations in sediments to levels that are protective of human health, including tribal and subsistence populations, from incidental ingestion of and dermal absorption of contaminants in sediments, and from ingestion of fish and shellfish that bioaccumulate contaminants from sediments.
4. Reduce contaminant concentrations in beach sediments and beach seeps to levels that are protective of human health from incidental ingestion of and dermal absorption of contaminants in beach seeps and sediments.

5.2 Conceptual Site Model

EPA reviewed the preliminary Human Health Conceptual Site Model (CSM) that was proposed by the LWG in the RI/FS Programmatic Work Plan (April 23, 2004, Figure 5-6) and made a number of significant changes. The major changes are summarized below, and the revised Ecological CSM is provided in Figure 5.

Consistent with the CSM for the ecological risk assessment, for the “source side” (the left side) of the CSM, additional detail has been provided to better represent the complexity of the physical system. Primary, secondary and tertiary sources and release mechanisms were specified. For exposure media for human health, fish/shellfish were removed and added as an exposure route; porewater was renamed transition zone water; air and seeps were added; and sediment is now distinguished as beach versus in-water sediments.

For exposure routes, To be consistent with the eco CSM for exposure routes, inhalation was added. Other changes to exposure routes are: ingestion and dermal absorption from beach

sediments are evaluated separately from in-water sediments; ingestion and dermal exposure to seeps was added; and exposure to fish/shellfish contaminated as a result of exposure to sediments, transition zone water, and surface water are included. Shellfish now include bivalves as well as crayfish. Breastfeeding was also added as an exposure route. For receptors, two new worker categories (on-site and in-water workers) were added.

5.3 HHRA Approach

EPA has determined that a number of refinements are necessary to compete the human health risk assessment (HHRA). Refinements include the inclusion of worker and residential drinking water exposure scenarios, the evaluation of human consumption of clams and mussels using the biota data that is currently being collected; the addition of a diver scenario; the evaluation of indirect exposure to transition zone water (from bivalves and crayfish) and surface water (from fish); a distinction between in-water versus dockside workers; and an assessment of persistent, bioaccumlative, toxics (PBTs) in breast milk. These refinements are described in the following sections.

5.3.1 Drinking Water

EPA has determined that the Willamette River represents a potential future source of drinking water. This determination is supported by state water quality rules that include drinking water as a designated beneficial water use of the Lower Willamette River and the fact that the City of Wilsonville (RM 38) is currently utilizing the Willamette River as a drinking water source. The HHRA CSM has been revised to reflect this potential future route of exposure by adding residential and industrial drinking water exposure scenarios.

Surface water COPCs for evaluation in the baseline risk assessment should be identified by screening the maximum concentration of any chemical detected against federal Safe Drinking Water Act Maximum Contaminant Levels (SDWA MCLs) and EPA Region 9 residential drinking water PRGs based upon a "lifetime" residential exposure scenario (liters for day for 70 years assuming a cancer risk of 10^{-6} and a HQ of 0.1). For the risk characterization in the baseline risk assessment, exposure point concentrations (EPCs) should be calculated by calculating the 95th% UCL on the arithmetic mean of all surface water data collected. In addition, other data sets should also be assessed. These include surface water data collected off shore of specific facilities or sources, in selected exposure areas (e.g., areas selected for transient and recreational exposure) and within specific areas of the river (e.g., river transects). EPCs should be used in the standard drinking water residential and worker scenarios provided in EPA's Superfund guidance (e.g., for residential exposure, use of 2 liter/day; 30 years exposure for adults for cancer; 6 years for children for non-cancer).

Exposure to surface water for transients (as a drinking water source) and for recreational users (inadvertent ingestion) is already in the CSM and screening criteria and exposure methods and parameters for the risk characterization are already described in the programmatic work plan. Exposures are assumed to occur in only selected parts of the Portland Harbor Site for transients and recreational beach users. These exposure scenarios do not require modification.

5.3.2 Consumption of Clams and Mussels

Ongoing Round 2 RI/FS data collection efforts include collection of benthic invertebrate tissue. In particular, freshwater clams, *Corbicula*, and freshwater mussels will be collected at a range of locations across the site. Although the current HHRA work plan does not include as assessment of the risks associated with human consumption of bivalves, bivalves should be included in the HHRA because: 1) A discussion with one diver has verified that he has collected bivalves from the Lower Willamette River for consumption by himself and his family (he no longer collects bivalves from Portland Harbor because of concerns about the effects of pollution; 2) information provided by the Oregon Department of Human Services (DHS) documents that transients living along the river sometimes collect clams for human consumption; 3) bivalves should be a resource that is available for consumption now and in the future; 4) unlike fish species, bivalves do not metabolize PAHs and may be contaminated with these compounds; and 5) evaluation of risk for bivalves will provide information to DHS about the need for a consumption advisory.

The HHRA CSM as been modified to include crayfish and bivalves under the term "shellfish." The ongoing benthic tissue sampling (clams and mussels) will result in samples collected over a relatively large area and composited. As a result, EPA has determined that each composite sample (station location) should be evaluated individually. This is consistent with the evaluation of the Round 1 biota data and will aid our understanding of localized impacts associated with specific sources of contamination.

The consumption rate agreed upon for crayfish (18 g/day) should be used for evaluating the risks associated with bivalve consumption. Because bivalves will be collected over a relatively large area and composited, EPA has determined that each composite sample (station location) should be evaluated individually. This is consistent with our evaluation of the Round 1 biota data and will aid our understanding of localized impacts associated with specific sources of contamination.

5.3.3 Indirect Exposure to Transition Zone Water and Surface Water

The Programmatic Work Plan includes the following statement: "Contaminants in surface water may be a source of contaminants in biota tissue. For the risk assessment, exposure to contaminants in surface water via biota tissue will be assessed as a part of the risk assessment for fish and shellfish. However, as a part of the RI/FS for Portland Harbor, surface water data collected in all areas of the site will be compared to EPA's Ambient Water Quality Criteria for fish consumption and Oregon Water Quality Standards." This statement should be modified. For evaluating the risks of consuming biota contaminated by TZW and surface water, the HHRA should include use of the WQC for screening of transition zone water (TZW) and for selection of COPCs for surface water.

As now written, the HHRA work plan assumes that evaluation of Round 1 fish tissue data will be sufficient for assessing risks presented by surface water. Evaluation of surface water data as a pathway to biota by humans will be evaluated through a comparison to AWQC for the protection of human health. These concentrations are based on a fish consumption rate of 17.5 g/day.

The approach for estimating risks to human health resulting from indirect exposure to transition zone water has not been agreed upon. Transition zone water data will only be available offshore of facilities where movement of contaminated groundwater into the surface water is suspected. TZW data will not be available from many other areas including those areas where clean water may be moving through contaminated sediments and where contaminated groundwater is discharging farther offshore. EPA has determined that transition zone water should be evaluated by comparing transition zone water results in areas of contaminated groundwater discharge to human health AWQC (based on 17.5 g/day) as a surrogate for bioconcentration of contaminants into bivalves and crayfish (the agreed upon crayfish consumption rate is18 g/day). This comparison should be performed for all chemicals for which fish consumption AWQC are available. For other chemicals (e.g. perchlorate) a WQC for human health may need to be calculated. Transition zone water data should be evaluated on an individual data point basis as well as a calculated averaged over the area of the contaminated plume discharge. This data should be used to evaluate consumption of crayfish, clams and mussels.

The current efforts to characterize transition zone water in areas of contaminated groundwater discharge are expected to be adequate to estimate contaminant levels associated with contaminated groundwater plumes. However, this will not address the issue of contaminant levels in TZW in areas where clean groundwater is moving through contaminated sediment or in areas where groundwater is in equilibrium with clean or contaminated sediments. In areas where clean groundwater is discharging to the Willamette River through contaminated sediments, the food web model should be used to evaluate the uptake of contaminants by crayfish, clams and mussels.

For surface water, both a screening to select COPCs and a risk characterization should be performed. Individual sampling points should be screened against AWQC calculated using a fish consumption rate of 175 g/day to select COPCs. AWQC based upon 175 g/day should be used as a surrogate for bioconcentration/bioaccumulation of contaminants into fish tissue. AWQC may need to be calculated for some chemicals, such as perchlorate. For the risk characterization in the baseline risk assessment, exposure point concentrations (EPCs) should be calculated by calculating the 95th% UCL on the arithmetic mean of all surface water data collected. In addition, other data sets should also be assessed. These include surface water data collected off shore of specific facilities or sources, in selected exposure areas (e.g., areas selected for transient and recreational exposure) and within specific areas of the river (e.g., river transects). EPCs should be used with BCFs from the WQC documents to calculate biota concentrations. For SW, all fish consumption rates specified in the programmatic work plan should be used (17.5 g/day, 73 g/day, 142 g/day and 175 g/day for adults). These results should be compared to the biota tissue that has been collected for the Portland Harbor site.

5.3.4 Direct Exposure to Sediment

On February 24, 2005, EPA commented on the LWG's interim deliverable on exposure to in-water sediments: "Exposure Point Concentration Calculations Approach and Summary of Exposure Factors" (EPC Interim Deliverable) dated December 3, 2004. During a subsequent conference all, EPA and the LWG were unable to resolve our differences. EPA has revisited our

February 24, 2005 comment letter. In the near future, EPA will be provide direction to the LWG regarding resolution of EPA's February 24, 2005 comments.

Exposures to divers were not addressed in the EPC Interim Deliverable, however, the HHRA work plan states: "It is assumed that the recreational beach user, which includes exposure to surface water during swimming activities, will be protective of divers in Portland Harbor. This assumption will be reassessed when additional information regarding divers in Portland Harbor becomes available, and, if needed, a diver receptor may be included in the HHRA." The diver scenario has now been added to the HHRA CSM. Further discussion is required to determine the appropriate exposure assumptions for this scenario.

5.3.5 PBTs in Breast Milk

The HHRA Work Plan states: "Within the consumption fisher receptors, pregnant and nursing women are a subgroup of potential concern due to potential exposures to fetuses and nursing infants and will be discussed further with EPA and its partners."

EPA has determined that this exposure should be included in the risk assessment. It is very likely to be an issue of concern for the public. In addition, EPA risk assessments (e.g., the Housatonic River) and EPA guidance (e.g., OSWER Combustion Guidance) include this pathway. And finally, evaluation of this pathway does not require that additional data be collected. Rather, Round 1 biota data, bivalve data now being collected, and the data from the ODHS study (salmon, sturgeon and lamprey collected and analyzed by Oregon Department of Human Services, ATSDR, the City of Portland and EPA) would be used to calculate infant exposures. Further discussion is required to determine which methods and exposure assumptions should be used to estimate exposures and to characterize the risks from this pathway.

5.4 Data Gaps

EPA has determined that additional data is needed to complete the HHRA. Data gaps are discussed in the following sections.

5.4.1 Smallmouth Bass Fish Tissue

Biota samples can be used for many purposes at the PH site, including, but not limited to: (1) Calculating risks to humans and ecological receptors; (2) Comparing biota in the site to those outside the site (e.g., to establishing "background"); (3) Calibrating and verifying the results of the food web model. Different data sets should be used for each; (4) Identifying PH site as well as source specific COCs; and (5) Following the change in contaminant levels before and after remediation and source control to gauge the effectiveness of these actions. EPA has determined that additional fish tissue sampling is needed to evaluate the risks to human health over localized areas and aid the understanding of background conditions.

Smallmouth bass, carp and brown bullhead contribute the majority of overall cancer risk at the Portland Harbor Site. Smallmouth bass have the advantage of a relatively small home range. Smallmouth bass collected during Round 1 of the sampling during Round 1 of the Portland

Harbor RI/FS included five fillet and fourteen whole body composite tissue samples. Composite samples were comprised of individual fish collected throughout a 1 mile reach from both sides of the river. EPA has determined that additional smallmouth bass should be collected off-shore of selected facilities to estimate localized risk from specific sources of contamination. Fish tissue sampling efforts should be focused on areas where persistent bioaccumlative toxins (PBTs) are present (e.g., Gunderson, Arkema, Rhone Poulenc, GASCO and Oregon Steel Mills).

In addition, bass as well as other species, such as carp, or brown bullhead (which along with bass had the highest contaminant levels of the fish collected in Round 1 for the HHRA), may need to be collected as part of any work to define "background" or "upstream " contaminant levels in biota. Any data collected in the future for the ERA (e.g. sturgeon) should be collected in a manner that would also provide data for the HHRA (e.g., by analyzing fillet separately from the rest of fish).

5.4.2 High Detection Limits for PAHs in Fish Tissue

As stated in previous EPA comments, PAH fish tissue detection limits did not achieve the specified ACGs. As a result, future biota tissue collection efforts that will be used for assessment of human health risk should attempt to achieve detection limits for the carcinogenic PAHs that are close to the ACGs calculated for the Round 1 QAPP as practicable. This may require use of high resolution GC/MS methods as was done for analysis of biota as part of DEQ's Mid-Willamette study.

5.4.3 PBDEs

Polybrominated diphenyl ethers (PBDEs) were detected in fish tissue samples collected through the Oregon Department of Human Services, ATSDR, the City of Portland and EPA. In addition, elevated levels of PBDEs were detected in a sediment sample collected off shore of the Schnitzer Burgard facility. PBDEs may represent a risk to human health. As a result, future biota tissue collection efforts that will be used for assessment of human health risk should include analysis of PBDEs. Sediment data collection should also be considered to evaluate potential source areas. High resolution GC/MS analysis will be required to properly analyze tissue samples; low resolution GC/MS may be adequate for sediment.

Section 6 Recommendations for Moving Forward

EPA has identified a number of data needs necessary for completion of the Portland Harbor RI/FS. In addition, EPA has refined elements of the human health and ecological risk assessment approach. EPA has determined that the identified data gaps and refinements to the risk assessment approach are necessary to complete the Portland Harbor RI/FS. EPA has not specified the precise level of sampling required to complete the characterization phase of the RI/FS. EPA recognizes that further discussion with the Lower Willamette Group is necessary to develop the specificity required to produce field sampling plans and complete the human health and ecological risk assessments.

The current project schedule calls for the submittal of the Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report (Comprehensive Round 2 Summary Report) in April 2006 followed by a Round 3 Field Sampling Plan (FSP) in May 2006. EPA has determined that the Comprehensive Round 2 Summary Report and Round 3 FSP should be submitted concurrently. Outstanding deliverables (Revised Groundwater Pathway Assessment Sampling and Analysis Plan, Step 2 Natural Attenuation Report, Approach to Determining Background for the Portland Harbor Superfund Site Technical Memorandum, COPC Selection Interim Deliverable, Round 2 Benthic Assessment Interpretation Report, and Literature Survey of Treatability Studies should be submitted no later than February 1, 2006 in order to ensure that all Round 3 data gaps are properly identified. A summary of EPA's proposal for submitting the deliverable described above is include in Table 8. The Round 3 FSP should include data collection efforts to address the four categories of data gaps identified in this document (Conceptual Site Model, Areas of Potential Concern, Ecological Risk Assessment and Human Health Risk Assessment). Ongoing Round 2 sampling efforts (e.g., archived sediment core sample analysis, Round 2B sediment cores, transition zone water and benthic tissue sampling) should be incorporated into the data gap analysis and development of the Round 2 FSP as data becomes available.

6.1 Conceptual Site Model

The next iteration of the conceptual site model is scheduled to be included in the Comprehensive Round 2 Summary Report. This is a key element of the Comprehensive Round 2 Summary Report. All relevant existing data must be consulted to develop a comprehensive understanding of the relationship between contaminant sources, pathways, exposure media and receptors.

The Round 3 FSP should include a conceptual site model component that addresses the data gaps identified in Table 1 and any other needs identified based on the refined CSM to be included in the Comprehensive Round 2 Summary Report and the Approach for Determining Background for the Portland Harbor Superfund Site Technical Memorandum. The conceptual site model CSM FSP must include the following elements:

- Upstream sampling for the purpose of determining background and ambient conditions
- Upstream sampling between RM 11 and 14 for the purpose of determining whether upstream sources that may impact the Portland Harbor Study Area are present and to assist the identification of site boundary conditions.
- The collection of data necessary to estimate contaminant loading and to support the development of a robust contaminant fate and transport model.

This data will be used to further refine the CSM to be included in the Draft Remedial Investigation Report currently scheduled for delivery in early 2007.

6.2 Areas of Potential Concern:

The Comprehensive Round 2 Site Summary Report is considered a vehicle for the identification of data gaps. EPA believes that the Round 2 Summary Report still has value for this purpose. The Comprehensive Round 2 Summary Report should include conceptual site models for each

area of concern identified by EPA in Section 3 above. These conceptual site models should be used to further refine the data gaps identified for each area of concern. The Round 3 FSP should include an Areas of Potential Concern component that addresses the in-water data gaps identified by EPA in Table 5. The FSP must address the following data needs for each Area of Potential Concern:

- Contaminants of Interest
- Lateral Extent of Contamination
- Vertical Extent of Contamination
- Surface Water
- Transition Zone Water

Contaminant Source Area and Transport Pathway data gaps data gaps are expected to be filled by upland parties as part of upland remedial investigations and source control evaluations. This data will be used to support the draft feasibility study currently scheduled for delivery in late 2007.

6.3 Ecological Risk Assessment

EPA has identified a number of refinements to the ecological risk assessment approach. In some cases, this has generated the need for additional data to complete the ecological risk assessment. However, in other cases, further discussion between EPA and the LWG is needed to develop the appropriate sampling approach.

Changes in the risk assessment approach described in section 4.5 should be incorporated into a revised Comprehensive Ecological Risk Assessment Approach Technical Memorandum. This document should be submitted along with the Comprehensive Round 2 Summary Report. Further discussion between EPA and LWG is required to refine the approach for assessing lamprey, identifying data needs relative to the food web model and the benthic interpretative model. EPA comments on the Food Web Model Report received on November 4, 2005 should be used to identify data gaps relative to the food web modeling effort. The benthic Assessment Interpretation Report should be submitted by February 1, 2005 and should be used to identify additional data needs relative to evaluating sediment toxicity. A meeting to identify the approach for assessing risks to lamprey should be held in January 2005 and be used to identify data needs relative to the lamprey assessment.

The Round 3 FSP should include an Ecological Risk Assessment component that addresses the data gaps identified in Table 7 and any additional data gaps relative to the lamprey assessment, the food web mode and the assessment of risks to the benthic community through sediment toxicity testing.

6.4 Human Health Risk Assessment

A key element of the Comprehensive Round 2 Data Summary Report is the development of Preliminary Remediation Goals (PRGs) and the identification of data gaps necessary to complete the human health and ecological risk assessments. EPA is in the process of finalizing its

comments on the Process for Derivation of PRGs Technical Memorandum. This should be used as the basis for developing PRGs in the Round 2 Data Summary Report. As stated in Section 5.3.1 above, EPA has determined that the Willamette River represents a potential future source of drinking water. As a result, Round 2 surface water should be compared to Region 9 tap water PRGs and SDWA MCLs in the Round 2 Data Report and drinking water should be evaluated in the baseline human health risk assessment. In addition, EPA comments on the Groundwater Pathway Assessment Sampling and Analysis Plan remain unresolved. This document should be the vehicle for resolving issues related to the fish consumption exposure pathway and transition zone water.

The Comprehensive Round 2 Summary Report should also consider human consumption of bivalves (clams and mussels). Clam and mussel tissue chemistry results should be compared to a PRG based on a fish consumption rate of 18 g/day.

The need for additional fish tissue data has been identified as a key data gap for the human health risk assessment. The Round 3 FSP should include the collection of additional smallmouth bass tissue for chemical analysis. Chemical analysis should include improved detection limits for PAHs and the analysis of PBDEs.

6.5 Summary:

To date, a significant amount of historic and RI/FS data has been collected within and adjacent to the Portland Harbor site. This information has increased our understanding of the nature and extent of contamination within Portland Harbor and the associated risks to human health and the environment. However, given the size and complexity of the Portland Harbor site, it is also clear that additional data efforts are required to refine the site conceptual model, to evaluate contaminant fate and transport, to support the human health and ecological risk assessments and to evaluate remedial action alternatives in the feasibility study.

EPA has taken the time to review the existing data as well as the current risk assessment approaches identify the steps necessary to complete the Portland Harbor RI/FS. We have taken these steps in advance of the Comprehensive Round 2 Site Summary Report in order to be able to identify data gaps and develop field sampling plans that will allow completion of the site characterization phase of the RI/FS by the end of 2006.

Section 7 Tables and Figures